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CLEAN-TECH MINERAL SECURITY:
A THREE-PRONGED STRATEGY FOR SUPPLY DIVERSIFICATION IN LATIN AMERICA

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In order to decrease dependence on fossil fuels, the U.S. military and private sector are increasing investment in clean-technology energy sources, such as solar, wind, and electric power. Clean energy development, however, is promoting dependency on a small set of states who currently supply the majority of clean-technology minerals. Competition for these minerals will grow as global energy demands increase and more countries adopt clean energy policies.

To prevent mineral shortages, costly price increases, and political costs associated with this dependence, the United States should adopt a three-pronged clean-technology mineral policy in Latin America. To diversify and stabilize the supply of these crucial minerals, this policy combines repayable contributions for American mineral exploration, conditional export-based development aid, and foreign fellowships in geology and mining technology.

Greening the Global Economy

Global Clean-Tech Energy Growth

The global middle class is expanding by 70 million new members a year[1], causing a predicted 49% increase in energy consumption by 2035.[2] Skyrocketing energy demand, combined with increased clean-energy policies, will deepen competition for clean-tech minerals:

- *Clean Energy Policies*: China spent $221 billion of its 2009 stimulus package on clean energy and requires utilities to produce 8% of their power from renewable sources by 2020.[3] In 2010, India launched a program to become "a global leader in solar energy" manufacturing and installations.[4]

- *Clean Energy Projections*: Wind generated power is projected to increase from 1.6% to 8.4% of world electricity production by 2019,[5] and solar installations are expected to increase to 12.5 times their current numbers in the next ten years.[6]

United States Clean-Tech Energy Growth

Forty-seven states now offer incentives for alternative-energy use,[7] and the Department of Defense adopted a comprehensive energy strategy to develop clean power sources for the military.[8] Certain technologies will become increasingly critical in this transition:

- *Solar Panels*: Construction of the world's largest solar array is underway in California.[9] Solar panels already power UAVs[10] and military bases, and the Defense Department plans to increase the use of portable solar panels for on-site energy generation.[11]

- *Electric Vehicles*: 108 electric-drive vehicle models are predicted to be on the U.S. market by 2015, up from 22 hybrid models and one fully electric vehicle model in 2010.[12] It is predicted that the United States will be able to make 40% of the world's advanced batteries by 2015.[13]

- *Wind Turbines:* Large wind farms are under development along the Atlantic and Pacific coastlines,[14] and the Army has begun testing portable wind turbines for rapid and deployable energy generation.[15]

Critical Clean-Tech Minerals

The transition to clean energy relies on a dozen non-fuel minerals which will become increasingly critical and pose potential supply risks to the United States. These minerals include:

Heavy Rare Earths (e.g. Dysprosium, Europium, Terbium, Neodymium, and Yttrium)

- *Clean-Tech Uses*: These minerals are critical to the manufacture of batteries, electric vehicles, solar panels, and wind turbines.

- *Current Sources*: The United States relies on China for 97% of its rare earth elements (REE) and has no domestic source of production or refinement.[16]

- *Supply and Demand Projections*: Each of these elements is deemed "critical" by the Department of Energy (DOE).[17] Between 2008 and 2014, world demand for REE will increase by approximately 150%, driven by increasing consumption of clean technology. Expert projections indicate that heavy rare earths will likely be the first to suffer shortages,[18] with demand for terbium, dysprosium, and yttrium all expected to equal or outpace supply by 2014.[19]

Indium

- *Clean-Tech Uses*: Indium is primarily used in solar panels, particularly copper-indium-selenide (CIS) thin-film solar cells.[20]

- *Current Sources*: The U.S. is 100% import-reliant on indium, and China accounts for 40% of all indium imports to the United States. Most indium refinery production occurs in China, Japan, and South Korea, all of which have booming high-tech industries and will have high internal demand competing for refined indium supplies.[21]

- *Supply and Demand Projections*: Indium is deemed "near-critical" by the DOE and critical by the UN Environment Programme (UNEP). Rapid growth in CIS thin-film photovoltaic cells and other technologies is expected to increase indium demand eight-fold by 2030.[22] Moreover, recycling possibilities for indium are limited.[23]

Lithium

- *Clean-Tech Uses*: Lithium is the key component of lithium-ion batteries used in hybrid-electric vehicles (HEV).[24]

- *Current Sources*: From 2005-2008, 98% of lithium imported to the United States came from either Chile or Argentina, and all domestic production came from a single U.S. company.[25]

- *Supply and Demand Projections*: Lithium is considered "near-critical" by the DOE.[26] The percentage of lithium used in batteries continues to expand significantly, and recent projections show hybrid electric vehicles (HEV) as the major use of lithium worldwide by 2050.[27] The automotive market alone is projected to reach $337 million in 2012 and $1.6 billion in 2015.[28] Mitsubishi estimates that demand for lithium will surpass supply in under 10 years unless new supplies are found.[29]

Additional Clean-Tech Minerals

- Other "green minor metals," or metals used in clean technology, include germanium, tantalum, cobalt, gallium, PGMs, tellurium, and the "light" rare earths.[30] These elements are all critical to clean technology; however, they currently show less vulnerability to supply shortages and strong foreign dependencies.

Necessity of Government Intervention in Transitional Period

The free market is currently unable to address the threat of growing clean-tech mineral dependence. In the short- to medium-term, government intervention is necessary to avoid severe political and economic costs associated with the failure of the markets to diversify and secure new clean-tech mineral supplies.

Causes of Market Failure

The underlying cause of the failure of the markets to resolve this dependence is the large uncertainty associated with exploration, mining, and the potential end demand for these minerals in manufacturing. This uncertainty leads to the following:

- *Concentration of Exploration Activities*: It is in the United States' best interest to diversify mineral supplies to decrease the risk of supply disruptions. Exploration companies, however, are motivated by opposing interests, tending to concentrate their exploration in areas where mining is already underway to decrease risk and primary capital and transaction costs.

- *The "Hold-Up Effect"*: The high sunk costs of exploration create a hold-up effect, limiting new exploration.[31] Firms are increasingly buying pre-explored properties, rather than taking the risk of grass-roots exploration.[32] Early stage, or "grassroots" exploration, has dropped on average 2.5% annually since 2001, reaching 33% of total exploration in 2010.[33] Moreover, grassroots exploration has almost completely disappeared in many high-risk countries. If this trend continues, the finite number of unexplored economic deposits will continue to be lost to foreign companies who can bare the risk of exploration due to government backing, such as Chinese enterprises.

- *Price Volatility*: Extractive industries are highly susceptible to large price volatility. This volatility is credited to the lack of diversification of mining projects among a large number of countries, as well as the growing practice of using the commodity futures market as long-term portfolio items. Volatility in mineral prices is expected to increase due to the growing demand for minerals by developing countries, especially China.

Negative Implications of Market Failure

- *Economic Effects*: Much like oil, the volatile prices of minerals could cause a ripple effect in all levels of government and private business.[34] Macroeconomists have considered changes in the real price of oil as a key source of powerful economic fluctuations ("business cycles") and a cause of global economic shock.[35]

- *Political Effects*: Reliance on a limited number of foreign suppliers could cause the United States to finance or militarily defend hostile regimes. Moreover, the loss of mining sites to foreign companies who can bear greater risk not only has negative consequences for securing minerals, but it results in a loss of American influence in these countries vis-à-vis foreign investors in the region, particularly China.

Insufficiency of Proposed Government Intervention

United States policymakers have proposed various solutions for preventing critical mineral vulnerability, including reconstituting the domestic supply, increased recycling efforts, and stockpiling. These policies, however, prove insufficient to address the scope of escalating global mineral competition. Moreover, they make no attempt to resolve the underlying conflict between the interests of private companies and U.S. mineral security.

Reconstitute Domestic Supply

Rare earth mining sites are set to reopen in California, Idaho, Montana, and Colorado.[36]

Strength: A greater domestic supply will help negate the risk of both absolute shortages and those due to political conflict.

Weakness: Building a U.S.-only supply chain will not satisfy domestic demands, as the projected resources of the mines currently under development are not expected to meet domestic needs for heavy REE.[37] Moreover, other clean-tech minerals exist in much more profitable concentrations outside the United States.

Recycle Clean-Tech Minerals

Specialty metals are currently only recycled at a rate of 1%,[38] however, this rate is set to increase as rising specialty metal prices and new recycling technologies make the process more profitable.

Strength: Investment in recycling technology will spur American research and development and allow new, more efficient techniques to develop.

Weakness: Recycling minerals from electronic devices produces small yields, is technically challenging, and very expensive. Each ton of rare metals processed yields only a few hundred grams of recycled specialty metals.[39]

Stockpile Clean-Tech Minerals

In 1939, the U.S. government created a stockpile of strategic materials to preclude a dangerous and costly raw material dependence on foreign sources in times of national emergency. Currently, the only green minor metals in the stockpile are cobalt and platinum.[40]

Strength: Stockpiling ensures a supply of critical minerals during shortages and would lessen the incentive of foreign nations to strategically cut off mineral exports.

Weakness: Stockpiling only serves as a short-term solution, and stockpiles are expensive to constitute and maintain. Moreover, the Committee on Assessing the Need for a Defense Stockpile has repeatedly concluded that the current design and structure of the NDS is "ineffective in responding to modern needs and threats."[41]

Adopt a Three-Pronged Policy for Clean-Tech Mineral Diversification in Latin America

In order to secure clean-tech mineral supplies, the United States must diversify its access to mineral sources, particularly in Latin America.

Benefits of Clean-Tech Mining in Latin America

Latin America provides the ideal base for greater diversification of clean-tech mineral sources, as it offers both attractive economic potential for corporations and strategic benefits for the United States. These strengths include:

- *Political Stability*: While political stability remains an area of concern for mining in Latin America, as a whole, Latin American countries are more politically stable than African countries. This relative stability lowers exploration risks as well as the political risks caused by negotiating trade agreements with authoritarian states.

- *Ease of Transportation*: 27% of Latin America is within 100 km of the coast, as opposed to Africa's 18%.[42] In wartime, the geographic proximity between South America and the United States will require the Navy to protect fewer sea lanes and would allow for over-land transport.

- *Resource Potential*: Latin America offers unparalleled potential for growth in resource exploration. The annual Fraser Institute survey of exploration companies shows that Latin American mineral deposits would be among the most attractive exploration sites in the world; however, lack of infrastructure and unfavorable government policies hinder greater exploration.[43] Because geological processes tend to form belts of ore deposits, the large and varied ore deposits present in Latin America suggest that many new ore deposits exist and remain to be explored.[44]

A Three-Pronged Strategy for Securing Minerals in Latin America

The United States should encourage diversification of exploration and mining in Latin America through the implementation of a three-pronged clean-tech mineral policy. This policy combines repayable contributions for American mineral exploration, conditional export-based development aid, and foreign fellowships in geology and mining technology.

1) *Conditionally Repayable Contributions for American Exploration Companies*

The United States government should encourage greater grassroots exploration in Mexico, Columbia, and Peru by providing conditionally repayable contributions to companies who explore for clean-tech minerals in these countries. These contributions would be similar to those Ontario's Northern Energy Program has implemented to support clean renewable energy generation.

The Department of Energy has already offered $26 billion in loan guarantees under the Energy Policy Act of 2005. While these loans exist to develop green energy technology in the United States, they do not make money available for securing the minerals necessary for the growing demand in these industries.

While lack of infrastructure and concerns over political stability and physical security have deterred FDI in these countries, relatively strong economic and political freedom scores, as well as large known mineral resource deposits, indicate the potential for greater foreign exploration and mining development.

By providing loans which do not have to be repaid in full if the project fails, conditionally repayable contributions for exploration allow the United States government to share the initial financial risk of greater clean-tech mineral exploration in these countries. This lowered risk will diversify the supply of minerals and help secure new raw materials that would otherwise be left unexplored by American companies.

2) *Conditional Export-Based Development Aid*

Export-based development aid packages should be pursued in Bolivia, Ecuador, and Guatemala. While limited infrastructure, lack of geological databases, and uncertainty concerning enforcement of existing mining regulations make extensive FDI politically and economically unviable, these countries show great mineral potential if their exploration could be encouraged.

For these reasons, the United States should engage in government-to-government agreements for exploration and development in these countries. The United States should agree to provide concessional loans and grants for the purchase of American-made capital for exploration and geological database development in exchange for a guaranteed supply of a negotiated percentage of minerals mined during the period of the loan.

The framework for such agreement would be based on the capital-for-resource policies pursued by many oil-importing nations in the 1970s, notably Japan's agreements with the USSR through which Japanese mining equipment was provided in exchange for a guaranteed percentage of all oil and coal mined.[45] Through these direct purchases, the United States should develop a clean-tech mineral reserve which

would be employed simply as a means for facilitating the transfer of resources between foreign mines and American markets.

3) *Training Fellowships for Specialists, Educators, and Policy-Makers*

The United States should institute scientific exchanges with Latin America based off the fellowship programs already administered by the USDA Foreign Agricultural Service for agricultural training. These fellowships would be made available to Latin American specialists, university faculty, and policy makers who are concerned with clean-tech mineral exploration, development, and trade. These fellows would be matched with mentors for formal training at U.S. technical universities, the USGS and other government agencies, participating private companies, and not-for-profit institutions.

Mining in Latin America Policy Strengths

- *Encouragement of Market Transition*: Unlike previous policy recommendations, each of these three policies will develop the infrastructure and human capital necessary to gradually draw down government involvement by allowing private American firms to find exploration profitable in a diversified set of countries.

- *Diplomatic Engagement*: Both the image and the influence of the United States are rapidly declining in Latin America. As China engages in heightened trade and dialogue with Latin American nations, these countries are increasingly turning to China for loans and for development of their export markets. Moreover, China has been using its increasing economic involvement to influence the recognition of Taiwan by foreign governments. By developing mutually-beneficial trade and exploration policies with Latin America, the United States has the opportunity to mitigate China's growing soft power in the Western Hemisphere.

- *Cost-Effectiveness*: The loan guarantees this strategy proposes will be comparatively inexpensive. Exploration for lithium and REE in 2010 totaled only $153 million globally for all stages of exploration.[46] By comparison, the United States spent approximately $6 billion in 2009 subsidizing biofuels, specifically corn ethanol and soybean-derived biodiesel.[47]

- *Mutually Beneficial Results*: The above policy includes provisions which will be largely beneficial to both the United States and Latin America.

  - Benefits to Latin America include:

    Accountability: Much like China's policies in Africa, development funds in the form of mining equipment and education will serve as an agency of

restraint against embezzlement, ensuring funds are being employed for development purposes.

Job Creation: Funds for infrastructure and database development will be a source of local job creation.

Technological Training: Training in mining and geology will provide valuable skills to specialists in these domains to make the extractive industry more efficient and profitable.

- Benefits to the United States include:

Local Skilled-Labor: Training fellowships will give American firms access to local skilled-labor and will lower the barriers to market entry by facilitating the flow of information and reducing cultural barriers. The presence of skilled labor in this field will contribute to the establishment of clean-tech mineral mining industry in these countries which will encourage supply diversification over the long term. Moreover, the time these individuals spend in America is likely to instill positive feelings towards the United States.

Policy Diversification: By incorporating government-to-government agreements, incentives for private industry, and vocational training, this policy takes a comprehensive, long-term approach to resolve dangerous mineral dependencies.

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